WHITE PAPER

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Prepared by Internet Solutions Engineering

Compaq Computer Corporation

CONTENTS

A message from Paul Smart, Vice President of Research and Development, Collaboration Services 0

Objective 0

GroupWise Architecture 0

Functionality of GroupWise 5.2 Server 0

GroupWise System Requirements 0

Client 0

Server 0

Performance Management 0

Overview 0

Novell Super Laboratory 0

Test Configuration 0

Test Procedure 0

Subsystem Performance Comparison 0

Performance Tuning 0

Bus System Tuning 0

Hard Disk Controller Tuning 0

NetWare Operating System Tuning 0

Performance Conclusions 0

System Processor 0

Memory 0

Disk Subsystem 0

Proof of Concept of Sizing the GroupWise Server 0

Novell GroupWise Performance Management on Compaq Servers

This Compaq White Paper provides the results of a performance analysis conducted by Novell and Compaq engineers on the GroupWise Server for Novell IntranetWare. The information here is based on technical knowledge acquired by both Novell and Compaq engineers while testing these products in a closely controlled environment.

This paper is for system integrators and network administrators with knowledge of Compaq Server products, Novell GroupWise, and IntranetWare. It is a supplement to the "Compaq Hardware Reference" document and the "Novell GroupWise 5.2" documentation. The results and conclusions of this paper provide

- *an understanding of how Novell GroupWise works, including performance impact with various hardware configurations.*
- *suggestions for improving your GroupWise Server for IntranetWare performance.*
- *recommendations for selecting the appropriate server hardware for your GroupWise Server for IntranetWare.*

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A MESSAGE FROM PAUL SMART, VICE PRESIDENT OF RESEARCH AND DEVELOPMENT, COLLABORATION SERVICES

The tests that Compaq performed in the Novell Superlab clearly demonstrate the overall scalability that GroupWise, IntraNetWare and Compaq servers can offer. The SuperLab is unique in that it provides a testing environment for 1000+ machines. The testing is much more realistic with no simulation of connected users or desktops.

The combination of IntraNetWare, GroupWise and Compaq servers delivers a level of performance, scalability and reliablity that will help customers realize the highest Return on Investment.

OBJECTIVE

One objective of this Compaq White Paper is to provide information to assist current customers running Novell GroupWise R5.2 for IntranetWare on Compaq servers in optimally configuring their server(s) to achieve the highest possible performance from their hardware and software. Information is also provided that will assist customers in making configuration upgrade decisions that may be based on an anticipated return in performance gains.

Another objective is to provide information to assist future customers in selecting the appropriate server hardware configuration for their operating environment. Data provided illustrates performance and system utilization that can be expected for various processor types, server memory quantities, and disk subsystem choices. Customers may use this data to determine which price-for-performance configuration would best suit their business needs.

GROUPWISE ARCHITECTURE

GroupWise offers expanded E-mail and Integration with Internet/intranet technologies. If you can use E-mail or a browser, you can use GroupWise.

The Internet has changed the face of business communications. While E-mail is fine for sending messages back and forth, in today's marketplace—where survival often depends on your ability to collaborate and share information—E-mail isn't enough. In order to work effectively, you need the tools to send and retrieve messages, access shared documents, store voice-mail messages and make appointments. Just as important, you need a tool that lets you get the information you need when and where you need it. With expanded Internet capabilities and an elegant, easy-to-use interface, GroupWise 5.2 is that tool. The following figure depicts the GroupWise 5.2 Architecture.

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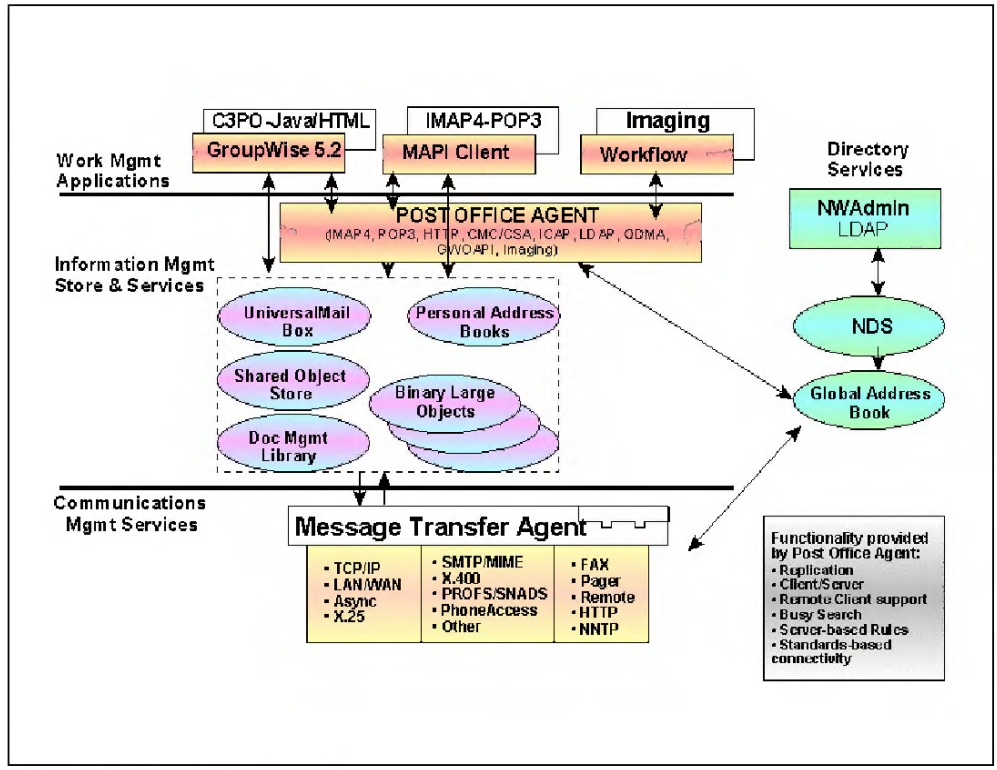

Figure 1. *GroupWise 5.2 Architecture*

Functionality of GroupWise 5.2 Server

- Full-featured E-mail
- Document management
- Calendaring and scheduling
- Workflow
- Imaging
- Remote Access
- Conferencing
- Paging
- Forms
- Voice mail integration
- Faxing capabilities
- Intranet/Internet integration
- and more...

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Everything You Need In One Place

The workplace is hectic enough without constantly having to search for E-mail, Web addresses, faxes, voice-mail, documents, appointments, and to-do lists. GroupWise allows you to gather all that information in one place, with a simple interface that's as easy to manage as E-mail. It's called the Universal Mailbox, and it even lets users store Web addresses that link directly to the referenced home page.

Get All Your Docs In Line

GroupWise Document Management lets several people work simultaneously on a single document. And a new feature, Jefferson Project technology, provides users with a full-featured Web publishing environment that allows them to easily collaborate on authoring, preparing and approving Web documents. It even keeps track of multiple versions of documents and monitors who's working on them. Jefferson Project technology enables you to manage corporate information on intranets and the Web, while providing the security, management and administration features required to keep that information secure, up to date and easily accessible.

Unify Network And Communications Administration

Running GroupWise with IntranetWare or NetWare 4 doesn't just offer incredible performance, it streamlines administration, as well. NDS™ (Novell Directory Services™) provides a global directory and single point of administration for GroupWise, IntranetWare or NetWare. So there's no duplication of effort when you're changing a user's address or modifying a user's rights. And with Novell and NDS, you can manage GroupWise remotely.

Anytime, Anywhere

With GroupWise WebAccess, you're always connected. Whether you're at your desk or on the road, you can download messages on any standard Web browser—allowing you to reply to messages, set appointments, and assign tasks on the fly. And GroupWise PhoneAccess is perfect for those times when you don't have access to a computer. Just call your Universal Mailbox to send and receive important E-mail messages through a pager, or check your messages and appointments using a touch-tone telephone.

GroupWise Keeps You Connected No Matter Where You Roam

Multiple Platforms And Gateways For Wide-Open Solutions

GroupWise runs on Windows 95*, 3.1 and NT*, as well as Macintosh* and the major versions of UNIX*. It also supports popular Internet browsers and the latest Internet protocols including SMTP/MIME, POP3, LDAP, IMAP and MAPI-compatible E-mail clients. GroupWise even offers multiple E-mail gateways.

Scalability For Any Size Enterprise

A true client/server application, GroupWise uses TCP/IP to communicate between workstations and servers—a natural solution when it comes to intranet/Internet integration.

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GroupWise Is In Good Company

With more than 7 million users, GroupWise is one of the most popular messaging solutions of its kind. If shared messaging and collaboration are hallmarks of your company, you need the reliable, powerful communications solution GroupWise provides.

GROUPWISE SYSTEM REQUIREMENTS

Following are the recommended requirements for GroupWise 5.2:

Client

Windows 95 or NT 4.0

Processor:	486/33 or higher
Memory:	16MB (for Windows 95)
	24MB (for NT)
Hard Disk Space:	Workstation 4MB
	Full install 24MB

Windows 3.1

Processor:	486/25 or higher
Memory:	8MB
Hard Disk Space:	Workstation 2MB
	Full install 20MB

Server

Agents (available for)

NLM:	IntranetWare, NetWare 3.1x or 4.x
NT:	3.51 or higher Novell Directory Services (NDS) Aware

PERFORMANCE MANAGEMENT

Overview

Performance Management can only be successfully achieved by fully understanding the performance impact that system resources such as the system processor, memory, and the disk subsystems components have on the overall operation of your entire system. Changing the configuration of these components affects performance in many ways. The goal of this section is to help customers understand the relationship between system resources and GroupWise Server performance. With this understanding, customers may make decisions regarding changes to an existing server configuration as well as complete configuration of a new installation.

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This section:

- defines two perceptions of performance
- describes performance analysis
- discusses standard and customized benchmarks as a performance measuring tool
- describes the testing methodology used during the study while focusing on Novell NetBench as the benchmark tool used for measuring performance of the CPU, memory, and disk subsystem.

Data gathered from Novell NetBench testing is presented and configuration recommendations are provided based upon data analysis and the experience of Novell and Compaq engineers.

Performance Characteristics

Performance can be viewed in one of two ways. To a system administrator, performance means effective management of system resources. A system administrator's concerns are system throughput and utilization. To an end user, however, performance is measured by system response time. In practice, it is necessary to balance the two perspectives; understanding that a change made to improve response time may require more system resources.

The purpose of this section is to provide the customer with an understanding of how GroupWise Server performed under various test configuration scenarios or benchmarks. Based on results from these tests, information is provided that can be used as a guideline for gauging the response time, throughput, and capacity expected of Novell GroupWise running on a Compaq server.

Performance Analysis

Performance analysis is an ongoing, interactive process necessary for determining whether or not your server is performing as it should. Performance analysis that is required as a part of performance management includes

- Understanding your user requirements
- Monitoring your server and network load patterns
- Making appropriate modifications to your configuration to achieve optimal use of resources

For the performance analysis investigation, Novell and Compaq engineers used a standard benchmark tool to examine the following GroupWise Server system resource areas:

- System Processor (CPU) Performance
- Memory
- Disk Subsystem
- Bus Architecture (PCI versus EISA)
- File Systems
- Networking

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Standard Benchmark Tool

A standard benchmark tool provides the ability to run the same test scenario under various operating environments to allow the comparison of one environment to another. For example, Test A executes a test script that initiates the execution of a fixed set of database or file operations for a consistent period of time on a hardware configuration, followed by the identical Test A running on another hardware configuration. The hardware configuration change implies that the processor, total system memory, network card, or disk subsystem configuration has been changed. To accurately measure the affect of configuration changes to one of these subsystems, all other variables are held constant except for the variable under test.

Customized Benchmark Tool

A customized benchmark is simply an extension of the standard benchmark tool. The customized benchmark provides the capability for test engineers to choose the type of workload from a number of provided profiles that most closely matches their real-world operating environment. Thus, one engineer's test results with a customized set of profiles should only be compared to other tests that used the same workloads. The output of the benchmark tools is raw data that must be analyzed before any conclusions can be made. The benchmark used in this test was developed by the Novell Engineering team. It has been customized to simulate the real world workload.

Novell Super Laboratory

The Novell SuperLab is an extensive testing facility available to internal Novell groups as well as third-party testing groups. The lab is designed to enable testing groups to conduct large scale tests resolving issues not encountered in typical lab environments. Resources include over 1700 computers, SMP resources, and telecom resources.

Test Configuration

Agent Configuration

The Post Office agent was configured using default settings, with the following exceptions:

- The TCPTHREAD count was set to 30
- The MFTHREAD count was set to 12

Hardware and Software Configuration

- Hardware System: Compaq ProLiant 5000
  Compaq ProLiant 800
- CPU: 200 MHz Pentium Pro (1-4)
- Memory: 128MB – 1GB memory
- Disk: Fast SCSI-2 and 8x2.1 GB
- Network: NetFlex3 (1-4)
- Network OS: IntranetWare 4.11
- Application: GroupWise 5.2

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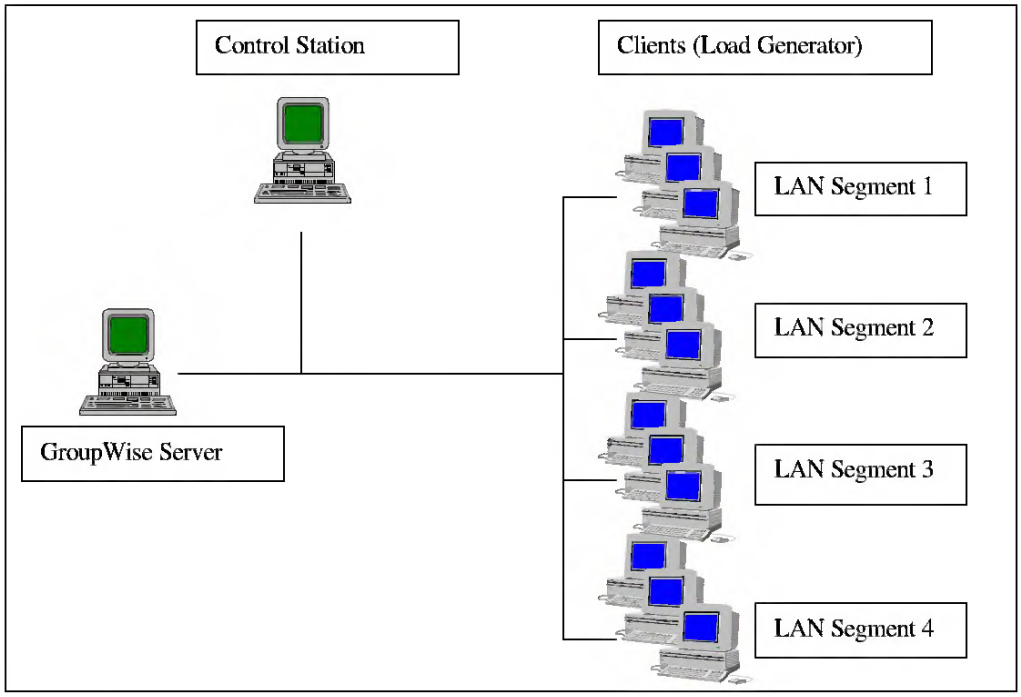

***Figure 2.** Testbed Layout*

Test Procedure

Novell and Compaq GroupWare Engineers initially performed several trial runs to determine the best test duration and confirmation of steady state. Both test duration and steady state were determined using real-time monitor utilities from IntranetWare. During the trial runs, engineers monitored the IntranetWare Performance Monitor and also logged the entire test process. For example, in the Network test, the team applied the same workload against four different LAN segments. In the first test, the team placed all 108 clients in one LAN segment and sent 20 mail items to 3 recipients. The team then separated the 108 clients into two LAN segments, with 54 clients each. Using the control station, the automated test scripts trigger the same tests.

The test data collected includes the following files:

- The Post Office Agent Log
- The STAT NLM output file
- Response time

Subsystem Performance Comparison

This section offers guidelines for obtaining optimal value and performance from your Compaq server. These guidelines are based on tests designed by Novell and Compaq engineers. The tests are based on the analysis of the data gathered from NetBench testing. A description of each of the subsystems, the data collected from testing, and recommendations for the configuration of your Compaq server are included in this section.

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The subsystems to be discussed are:

- CPU
- Memory
- Disk
- Bus Architecture (Bridge vs. Dual PCI)
- Networking

System Processor (CPU)

In contrast to a resource-sharing (file server) environment, a faster processor for an implementation of GroupWise on an IntranetWare Server yields faster client response times. In a resource-sharing environment, the system processor plays a less important role in performance tuning than the memory, disk, and network interface card. For Novell GroupWise, however, the processor is the most important subsystem for high performance.

In the testing performed by the Novell and Compaq team, the performance of the Pentium processors was compared to that of the Pentium Pro processors. The type of processor and its associated architecture features have as much impact on performance as processor-rated clock speed. For example, the Pentium Pro processor offers outstanding performance that is partially attributed to the incorporation of the following dynamic execution features.

- A superscalar architecture gives the processor the ability to execute multiple instructions per clock cycle.
- Internal register renaming supports the execution of concurrent instructions.
- Speculative execution of branches is supported via the processor's branch target buffer, which means the processor is able to predict the correct branch in most instances, thus increasing the number of instructions that can be executed out of order.
- The processor fetches and decodes numerous instructions, which are then sent to an instruction pool that schedules instructions that have no dependencies on prior instructions to be executed even if the instruction is out of order.
- Processor cache also has effect on performance. L1 cache(cache memory in the CPU it self) stores the most recent data and program instructions and provides this information to the server at the highest possible speeds. The systems L2 cache(near the CPU) has a 133 megahertz path to the CPU. L2 cache stores additional data and instructions. These two caches allow the CPU to function at higher rates of speed.
  Information that is not stored in either L1 or L2 caches must come from the main system memory at a speed of 66 megahertz, in turn slowing down the CPU. In other words, the larger the L2 cache is, the better performance will be.

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Memory

Memory is one of the most valuable resources in a Novell NetWare server. Memory is used for both disk cache as well as program execution. The detail memory requirement for NetWare 4.1 server can be found in *Novell Application Notes, January 1995*. In that calculation, the administrator needs to take a number of variables into consideration such as Total Disk Capacity, Total Number of Clients, Volume Block size, and so on.

GroupWise5 Memory Requirements:

The memory requirements are upper limits for a high-usage messaging system. The memory required on a server for GroupWise 5.2 varies depending on many factors. This document should not be used as an absolute tool for calculating memory requirements. A GroupWise system will run with less than the maximum amount of memory required, but performance will be increased with additional memory. Memory amounts stated are for GroupWise and not total system memory. Factors that may cause variances in calculations and performance are:

- Number of post offices and domains
- Number of TCP Handlers and MF worker threads
- Number of client/server connections being supported
- Number of active client connections vs. idle connections
- Message traffic between post offices and domains
- Separate processors for POA, MTA and ADA
- Dedicated Client/Server and MF worker processors
- IP or direct connections between MTAs
- High volumes of admin related traffic (user adds/deletes, NDS Sync, etc)
- High volumes of large messages (i.e. large attachments, remote updates, etc.)

Rule of Thumb for Memory Requirements

The largest amount of memory for GroupWise 5.2 is used while running the Post Office Agent (POA.) The Message Transport Agent (MTA) and the Administrative Agent (ADA) have smaller requirements. For the POA, three main groupings determine the memory requirements:

- Base memory for code, data and quick finder: 8,000,000 bytes
- Number of TCP handlers & MF workers: n* 2,000,000 bytes
- For C/S, number of concurrent connections: n* 50,000 bytes

Recommendation of Memory Requirements

The table below outlines the memory requirements for post offices with 100, 250, 500 and 1000 users. The memory requirements reflect the Post-Office Agent, Message Transport Agent and Administrative Agent. The memory requirements reflect peak usage at a time when all users are active. This information does not include requirements for the network operating system.

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Table 1. Memory Recommendation

Concurrent users	Machine recommended	Actual Server memory used During peak time.
100 Active users and actual Post-office; 100-250 users	Pentium 90 MHz	42MB
250 Active users and actual Post-office; 250-500 users	Pentium 133 MHz	104MB
500 Active users and actual Post-office; 500-1000 users	Pentium-Pro 200 MHz	116MB
1000 Active users and actual Post-office; 1000-2500 Users	Pentium-Pro 200 MHz	137MB

Disk

The disk subsystem has an impact on performance for all applications. The amount of I/O required by your application determines the degree of impact on the disk subsystem performance. Since Novell GroupWise is a very I/O-oriented application, the disk subsystem is an important contributor to overall system performance. Determining the impact of the disk subsystem involved analyzing the following options

- Drive Spindles/Striping
- Hardware Striping versus Software Striping
- Fault tolerance: RAID 0, RAID 1, RAID 4, RAID 5
- Controller type

Volume Block Size

The INSTALL program will set the default volume block size based on the size of Disk Volume. Depending on the type of files stored on the volume, or the application you used, you can increase or decrease the volume block size to improve the performance. The Novell/Compaq test team found that setting the volume block size to 64 KB yields the best result. The following graph shows the performance comparison.

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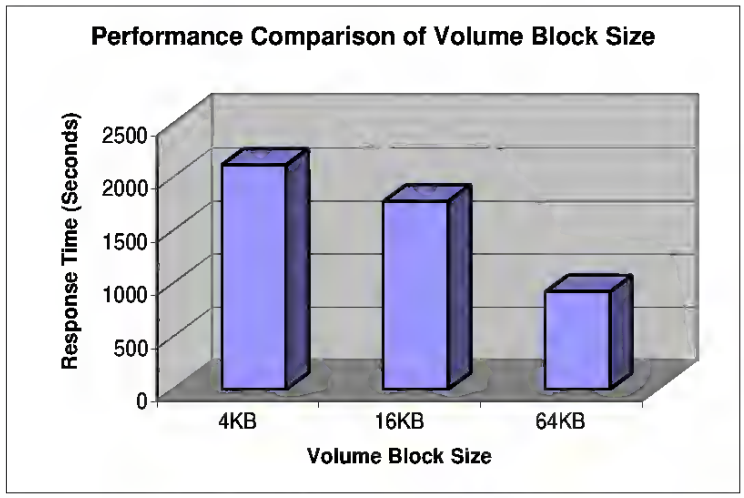

Figure 3. *Volume Block Size Performance Comparison*

The test results show that there is a measurable difference in response time rates between various volume-block sizes. The large VBS will increase the performance by 100% from 64 KB over 16 KB. The large block size will also save a lot of memory to load the volume; therefore, we strongly recommend using the largest volume block size.

Drive Spindles/Striping

If your applications generate significant disk I/O, there will likely be a lot more concurrent use of system services. You can improve the performance of your disk subsystem under load conditions by having your hardware logical drive span multiple physical drives using "striping." Striping allows the data to be written "across" a series of physical drives that are viewed by the system as one logical drive. This data distribution across drives makes it possible to access data concurrently from multiple physical drives that have been defined as one logical drive array.

Performance gains are achieved when you read from or write to the drive after the series of physical drives is united into one or more logical drive arrays. By distributing or striping the data evenly across the drives, it is then possible to access data concurrently from multiple drives in the series or array. The concurrent access of the data leads to higher I/O rates for the drive arrays than the spindles, thus improving your total system performance.

Table 2. *Drive Spindle Performance Comparison Mixed Load*

	Response Time (Seconds)
One Drive	823
8 Drives Hardware Striping (No Fault Tolerance)	803

Fault Tolerance

The customer has several available options when configuring the GroupWise Server and making a decision about the level of fault tolerance the system requires. Redundant Arrays of Inexpensive Disks (RAID)-level is a term used to refer to an array technology that provides data redundancy to increase the overall system reliability and performance. The fault tolerance method the customer selects effects the amount of available disk storage and the performance of the drive array.

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The following levels of fault tolerance support are available:

- RAID 5 - Distributed Data Guarding
- RAID 4 - Data Guarding
- RAID 1 - Disk Mirroring
- RAID 0 - No Fault Tolerance Support

The Compaq Smart-2 Array Controller is needed to support hardware striping and all levels of fault tolerance support. Features offered by the Compaq Smart-2 Controllers that are not found with Fast-Wide SCSI-2 Controllers are:

- Support for RAID 0, RAID 1, RAID 4 and RAID 5 Hardware Striping and Fault Tolerance
- Dual Fast-Wide SCSI-2 channels on a single board support up to 14 drives (7 per channel)
- Support for multiple logical drives per drive array
- Removable Array Accelerator - battery-backed 4 MB Read/Write cache with Error Checking and Correcting (ECC)
- Read-ahead caching
- Online Capacity Expansion and Disk Drive Upgrades
- Fault Management Features

RAID 5 - Distributed Data Guarding

RAID 5 is also referred to as distributed data guarding because it uses parity data to guard against the loss of data. The parity data is distributed or striped across all the drives in the array. RAID 5 provides very good data protection because if a single drive fails, the parity data and the data on the remaining drives is used to reconstruct the data on the failed drive. With Compaq Smart-2 controller technology, this reconstruction process allows the failed drive to be replaced while the system continues to operate at a slightly reduced performance. RAID 5 also offers good performance because spreading the parity across all the drives allows more simultaneous read operations.

The usable disk space when using RAID 5 depends on the total number of drives in the array. If there are three drives, 67 percent of the disk space is usable for data, with the remainder being used to support fault tolerance. If there are fourteen drives, 93 percent of the disk would be available. The tests that follow used seven drives.

RAID 1 - Drive Mirroring

RAID 1 is also referred to as drive mirroring. This is typically the highest performance fault tolerance method. RAID 1 is the only option for fault tolerance if no more than two drives are selected. Drive mirroring works as its name implies, storing two sets of duplicate data on a pair of disk drives. Therefore, RAID 1 always requires an even number of disk drives. From a cost standpoint, RAID 1 is the most expensive because 50 percent of the drive capacity is used for fault tolerance.

If a drive fails, the mirror drive provides a backup copy of the data and normal system operation is not interrupted. A system with more than two drives may be able to withstand multiple drive failures as long as the failed drives are not mirrored to one another.

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RAID 0 - No Fault Tolerance

RAID 0 means that no fault tolerance is provided. The data is still striped across the drives in the array, but it does not include a method to create redundant data. If one of the logical drives fails, data on that drive will be lost. None of the logical drive capacity is used for redundant data, so RAID 0 offers the best processing speed, as well as capacity. RAID 0 is appropriate for applications that deal with non-critical data requiring high-speed access.

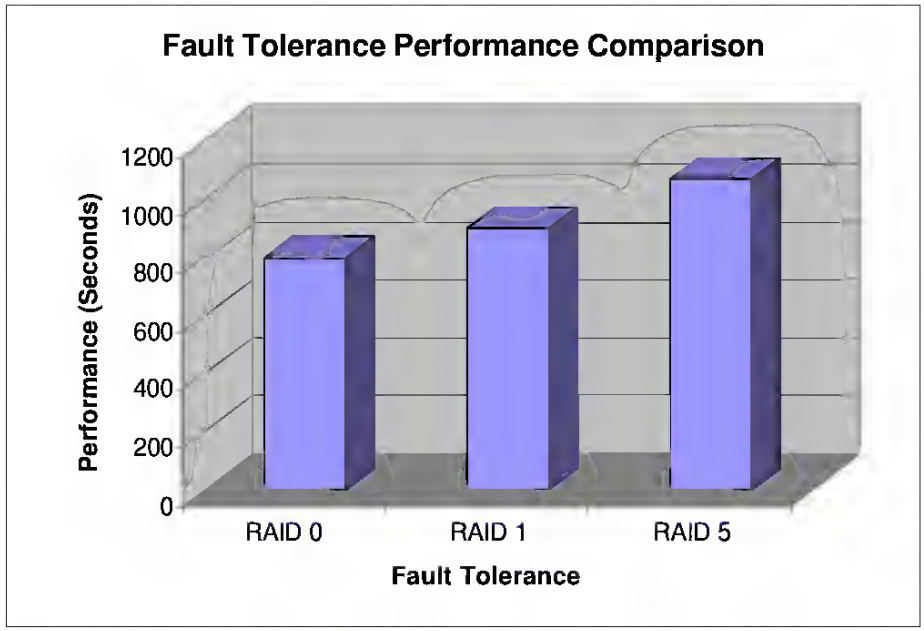

Figure 4. *Fault tolerance performance comparison*

Novell/Compaq test results show a measurable difference in response time rates between RAID 1, RAID 5 and RAID 0. RAID 0 achieved the best performance, outperforming RAID 5 by 10-20% in response. Keep in mind that while RAID 0 utilizes available disk space most efficiently, this level offers no fault tolerance protection. Based solely on response time, the recommendation would be to use RAID 1 over RAID 0 because of the performance gains expected, combined with the hardware fault tolerance protection. RAID 5 would be for data that is not mission-critical, and would offer better usage of disk capacity than RAID 1.

Smart-2 Controller's Array Accelerator Read/Write Ratio

The Array Accelerator has a read/write cache ratio that can be customized to fit your GroupWise Server activity using the Compaq Array Controller Configuration Utility. The configuration utility assigns 4 MB of cache memory to read/write operations. Ratios of 0% Read/100% Write, 25% Read/ 75% Write, 50% Read/ 50% Write, 75%Read/ 25% Write and 100% Read/ 0% Write are possible.

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The 75% Read / 25% Write ratio, yielding the best response time in our test, is recommended by Novell and Compaq engineers. This improvement in performance can be explained by the additional read-related work the test script performs.

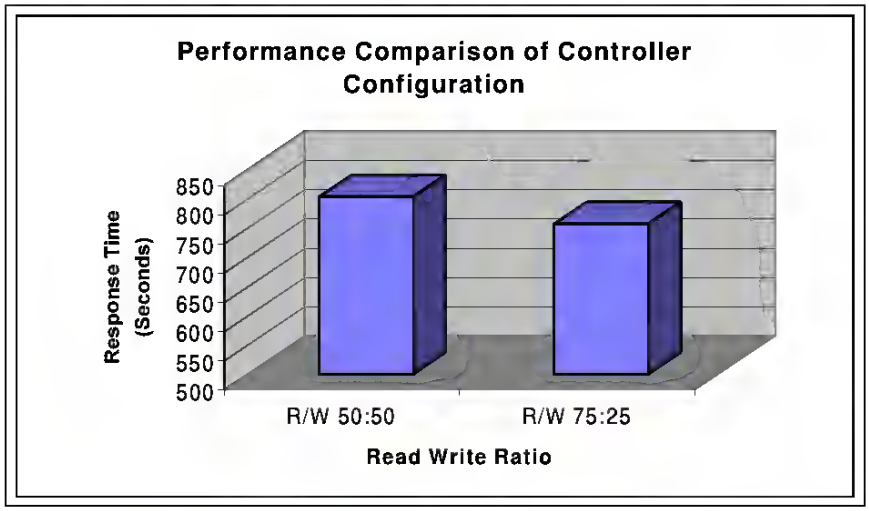

Figure 5. *Smart-2P Disk Array Controller Array Accelerator Configured with various Read/Write Ratios*

The chart above shows a performance comparison with the Array Accelerator read/write cache configured with two read/write ratios. As the chart illustrates, the 75% Read / 25% Write ratio yields the best response time for RAID 0.

Networking Subsystem

In a test environment that is purely Novell GroupWise, the networking subsystem is less likely to cause performance problems than the subsystem areas previously discussed. In an enterprise network environment, however, the network subsystem becomes a performance factor due to the replication that occurs between servers. The "Networking Subsystem" segment under "Performance Tuning" offers guidelines for identifying performance problems that are network-related. Also presented are network management guidelines, as well as strategies for increasing network throughput should this subsystem become the source of performance issues.

This section deals with two performance enhancement strategies: segmenting the LAN and increasing the LAN bandwidth.

Segmenting the LAN

A key strategy that can increase networking subsystem performance is dividing a single Ethernet segment into multiple network segments. If you determine the networking subsystem is not reaching optimum throughput, there are two network implementations that can improve the overall throughput and general performance gain of a network.

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- Physical segmentation

  To physically segment a network, you must first add more NICs to the server and then balance the network load among the multiple NICs. Segmenting a network by adding additional NICs and hubs has the added benefit of creating separate collision domains. Creating additional collision domains minimizes packet collisions by decreasing the number of workstations on the same physical network.

- Network switching technology (microsegmenting)

  Switching-hubs, much like routers and bridges, also provide LAN segmentation capabilities. LAN switches provide dedicated, packet-switched connections between their ports. The packet-switched connection provides simultaneous switching of packets between the hub ports, which increases the available bandwidth.

The following is the performance comparison chart for three different LAN segments:

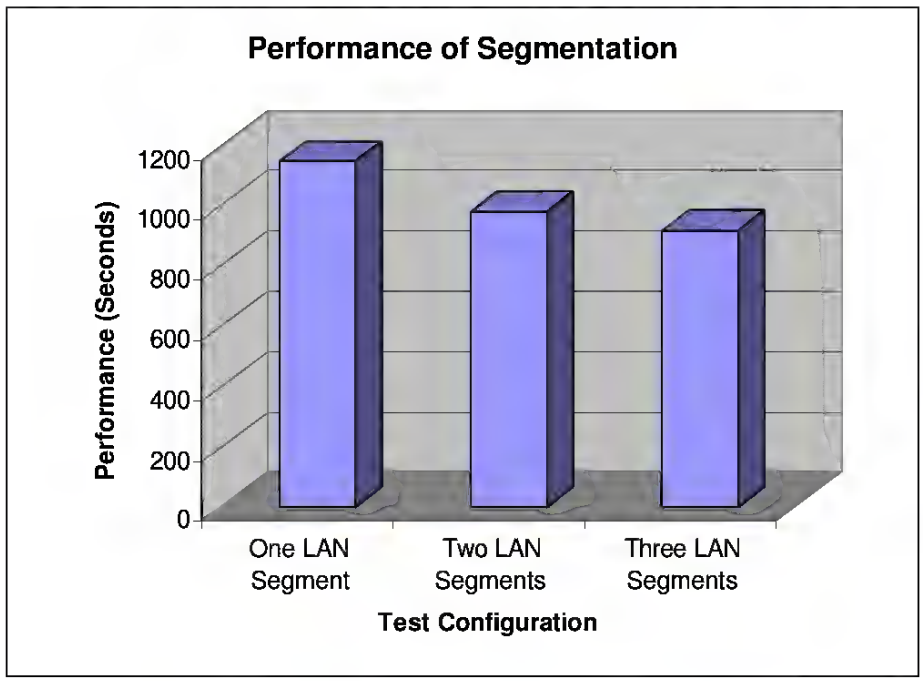

Figure 6. *Performance of Segmentation*

Migrating to 100-Mb/s Technology

Migrating a network Ethernet implementation from 10Base-T to 100Base-TX or 100VG-AnyLAN provides 100 Mb/s of shared bandwidth for the LAN clients. Implementing this type of change can substantially improve network throughput and overall performance.

A gradual migration to the faster Ethernet technology does not have to be expensive and time consuming. Partially converting your LAN is a viable alternative to converting all clients on the LAN simultaneously.

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The advantages of upgrading a server to a 100-Mb/s NIC while accommodating existing LAN clients with a bandwidth of 10 Mb/s are as follows.

- Cost effectiveness: upgrading is not as expensive as converting all clients at the same time
- Better throughput: aggregate network throughput is improved because the transmission speed is faster from the server to the hub
- Ease of upgrade: replacing your 10-Mb/s NIC with a 100-Mb/s NIC is not a difficult process
- No complex cable requirements: you can use your existing 10-Mb/s cable

The disadvantages of upgrading the server NIC to 100 Mb/s while leaving clients at 10 Mb/s are:

- Replacing existing 10-Mb/s NICs with the more expensive 100-Mb/s NICs might be cost-prohibitive, depending on the number of NICs being replaced.
- Re-routing all existing clients to a switching hub is required. Depending on the number of clients, this can be an inconvenience to an administrator.

Reviewing Migration Results

NOTE: The testing tool NetBench used for network subsystem analysis, is not the same as and should not be confused with the test program mentioned previously in this paper.

To compare and evaluate 10-Mb/s Ethernet and 100-Mb/s Ethernet, parallel test environments were set up in the integration testing labs at Compaq. The results, shown in Table 3, compare a 10-Mb/s Ethernet LAN with that of a 100-Mb/s Ethernet LAN. IntranetWare Performance Monitor indicates the total throughput for the NetFlex-3/P controller installed in the server. Compare the throughput of the 10-Mb/s NIC to that of the 100-Mb/s NIC. Theoretically, the maximum data transmission rate should increase by a factor of 10 when migrating from the 10-Mb/s NIC to the 100-Mb/s NIC. Table 3 shows the NetBench 4.0 throughput results for a maximum of 10 clients running at 10-Mb/s and 100-Mb/s Ethernet.

Table 3. Single Segment LAN Throughput

Number of Clients	Ethernet Bandwidth	Total Throughput (Mb/s)
4	10 Mb/s	9.3
10	10 Mb/s	9.4
4	100 Mb/s	69.3
10	100 Mb/s	90.1

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Figure 7 is a graphical representation of one Ethernet segment of 10-Mb/s and 100-Mb/s clients (IPX protocol). The results are from a NetBench 4.0 monitoring session where Total Throughput was captured for a ProLiant 1500 server equipped with a NetFlex-3/P Controller (100-Mb/s TX Module). The graph illustrates that the Total Throughput increased as the number of clients increased, then leveled off at 8 clients.

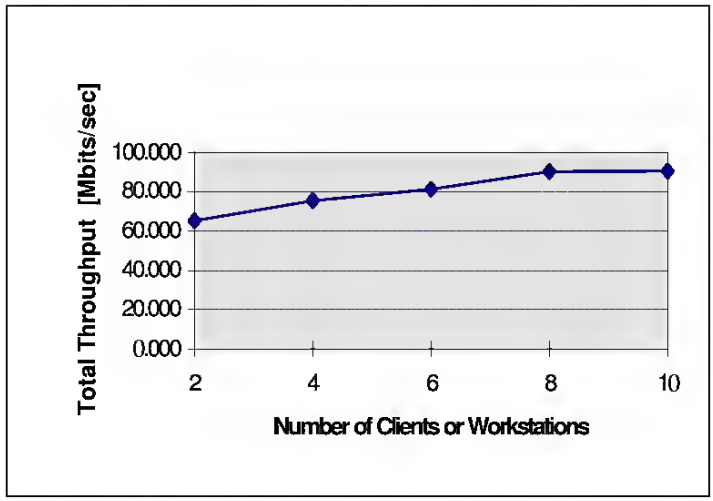

Figure 7.*Result of total throughput*

In general, if total throughput stays around 50 percent or better on a consistent basis, your LAN is approaching network saturation or may be bottlenecked. In both of our test cases, the LAN saturated at 8 clients. Reaching saturation level with such a low number of clients indicates a need for segmenting the LAN to distribute the work load.

As noted, these testing results indicate wire saturation for a very low number of users because NetBench creates a test environment that simulates network demand placed on a file server; every client reads the same data from a data file. The use of a synthetic network measuring program (NetBench) and the even distribution of work caused the low saturation point. Thus, this testing does not represent a typical LAN environment of several hundreds or thousands of users arbitrarily broadcasting over the entire LAN via router(s), bridge(s), and gateways. In a real-world environment, network clients should not reach wire saturation for so few users, as indicated in Table 3 and Figure 6. The table and graphical data show the wire bandwidth difference between 10 Mb/s and 100 Mb/s, as well as the effect of increasing the user load.

PERFORMANCE TUNING

Bus System Tuning

Compaq introduced dual peer PCI buses with the ProLiant 5000 for added performance and reliability. For performance, both buses are independent, allowing a full 267 MB/s of I/O. For added reliability, the ProLiant 5000 offers support for redundant 10/100 TX PCI UTP Network Interface Controllers (NICs) as well as redundant disk controllers. With redundant controllers installed, the system can remain operational even if a disk or network controller fails or if there is a PCI bus failure. Installing redundant controllers on separate PCI buses insures maximum possible reliability.

Slot 5, 6, 7, and 8 are on the primary bus; slot 2, 3 and 4 are on the secondary bus.

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In order to avoid I/O contention, the following Server Configuration of ProLiant 5000 is recommended.

Table 4. Server Configuration of ProLiant 5000

One network controller and one array controller		
Device	**Bus**	**Slot**
10/100 TX PCI UTP	Secondary	2
SMART-2/P Array	Primary	5
One network controller and two array controllers		
Device	**Bus**	**Slot**
10/100 TX PCI UTP	Secondary	2
SMART-2/P Array	Primary	5
SMART-2/P Array	Secondary	3
Two network controllers and one array controller		
Device	**Bus**	**Slot**
10/100 TX PCI UTP	Secondary	2
SMART-2/P Array	Primary	5
10/100 TX PCI UTP	Primary	6
Two network controllers and two array controllers		
Device	**Bus**	**Slot**
10/100 TX PCI UTP	Secondary	2
SMART-2/P Array	Primary	5
10/100 TX PCI UTP	Primary	6
SMART-2/P Array	Secondary	3

Hard Disk Controller Tuning

Some of these features offer performance and fault tolerance advantages, which were discussed in an earlier section detailing hardware versus software striping, and the number of drives supported in an array. Now the performance impact of the Smart-2 Controller Array Accelerator will be examined.

The Smart-2 Controller Array Accelerator serves as a read-ahead and write cache that dramatically improves the performance of read and write commands. The Array Accelerator performance gains are best seen in database and fault-tolerant configurations. The Smart-2 Controller writes data to 4 MB of cache memory on the Array Accelerator rather than directly to the drives, allowing the system to access this cache more than 100 times faster than accessing the disk. The data in the Array Accelerator is written later to the drive array by the Smart-2 Controller when the controller is otherwise idle.

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The Array Accelerator also anticipates requests as another method of increasing performance. A multi-threaded algorithm is used to predict the read operation most likely for the array. That prediction is used to pre-read data into the Array Accelerator so that data may be there before you access it. If the Smart-2 Controller receives a request for cached data, it can be burst into system memory at PCI or EISA bus speeds.

NetWare Operating System Tuning

SET Read-Ahead Cache

A GroupWise Server tunable parameter that impacts the system performance is the Read Ahead Cache which is the amount of memory allocated to the GroupWise Server specified in bytes.

Novell and Compaq engineers recommend using the default read-ahead cache due to the 15-20% performance gain show in the following figure.

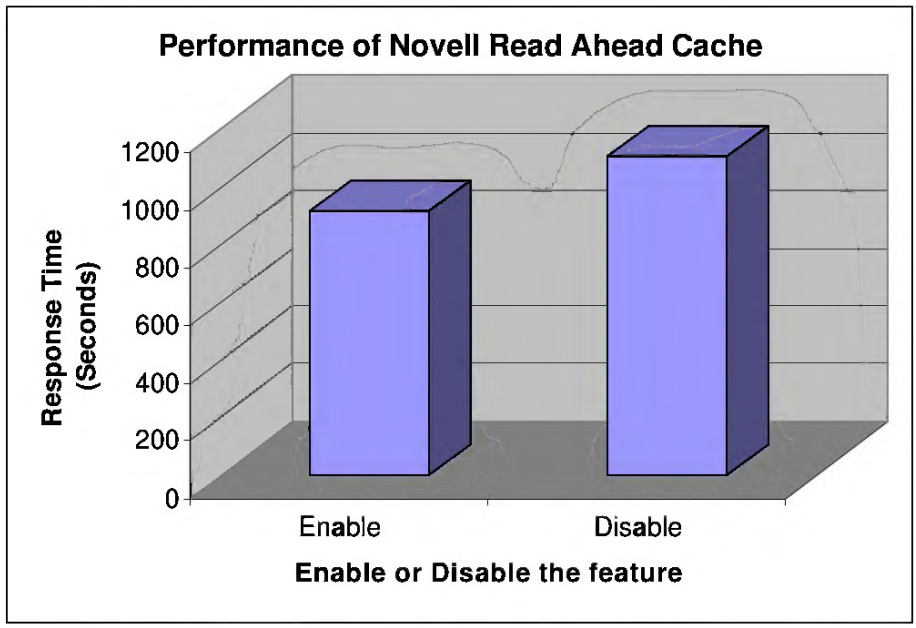

Figure 8. *Performance of Novell Read Ahead Cache*

SET Packet Receive Buffers

Another GroupWise Server tunable parameter that impacts system performance is Packet Receive Buffers. The more packet receive buffers a system has, the better the server's performance; however, these buffers use system memory needed by processes, so you must balance buffer allocation against available memory.

The server automatically adjusts the allocation of buffers between minimum and maximum. The server will allocate more buffers to handle the load. Over time, it will reach an optimum setting that provides the best performance; however, some performance degradation will occur during the system ramp-up. Novell and Compaq engineers preset the packet receive buffers to an optimum setting and yielded a 10-15% performance gain. Therefore, our recommendation is to use the MONITOR to determine what the server's dynamic allocation of Packet Receive Buffers, and change that parameter to what the server dynamically configured.

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PERFORMANCE CONCLUSIONS

This section presents conclusions and recommendations for performance management, based on the performance tests and data analysis carried out by Novell and Compaq engineers.

System Processor

Research clearly shows that the CPU was found to be the most important server subsystem affecting overall system performance of the GroupWise Server. The conclusion is that the faster the processor, the better the performance gains for the system. Therefore, Novell and Compaq engineers recommend the fastest processor that can be purchased within the budgetary limitations of your project. Furthermore, the performance of the Pentium Pro Processor clearly shows that its superior features help contribute to the improvement in performance over the Pentium Processor rated at the same clock speed.

Memory

In addition to the IntranetWare's memory requirement, please add the following memory to the system total memory:

Table 5. *Memory Recommendation*

Concurrent users	Machine recommended	Actual Server memory used During peak time.
100 Active users and actual Post-office; 100-250 users	Pentium 90 MHz	42MB
250 Active users and actual Post-office; 250-500 users	Pentium 133 MHz	104MB
500 Active users and actual Post-office; 500-1000 users	Pentium-Pro 200 MHz	116MB
1000 Active users and actual Post-office; 1000-2500 Users	Pentium-Pro 200 MHz	137MB

Disk Subsystem

Novell and Compaq engineers recommend disk striping to benefit from the gain in I/O performance. The recommendation is to use numerous smaller drives in an array rather than a few larger drives to achieve the best overall system performance providing comparable storage capacities.

Hardware striping is recommended due to performance gains, as well as more system resource efficiencies than when using software striping. Hardware striping is achieved by Compaq's Smart-2 Array Controller, which also has built-in data protection features, adding another benefit over software striping.

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Fault Tolerance is strongly recommended by Novell and Compaq engineers. RAID 1 is the preferred level of fault tolerance for systems that have mission-critical data, while RAID 5 is recommended for systems storing non-critical data. RAID 1 is the preference due to a combination of high level performance and protection of the data. RAID 1 uses disk mirroring, providing good data protection at the cost of low utilization of actual disk capacity. Disk mirroring uses 50% of available disk space for fault tolerance support. RAID 5 uses distributed data guarding, striping data and parity data across all drives in the array. The more drives in the array, the lower portion of each drive reserved for fault tolerance support. Set the Smart Array Controller read/write ratio to an appropriate level. In our test case, the optimal ratio is 75:25, due to the read-intensive environment. However, because this parameter is very application-specific, users should do their homework before changing it. Using the largest volume block size is recommended.

PROOF OF CONCEPT OF SIZING THE GROUPWISE SERVER

Preliminary tests show that a ProLiant 800 can successfully sustain 500 users and a ProLiant 5000 can sustain 1000 users. These tests prove that Compaq is a viable solution for GroupWise needs. More detailed information will be forthcoming after extensive testing at Novell's SuperLab facility in Provo, Utah. At the SuperLab, the full Compaq Server product line in multiple configurations will be tested under client loads in excess of 1000 users.

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